PATENT ABSTRACTS OF JAPAN

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(54) EXTRUDED TUBE

(57)Abstract:

PROBLEM TO BE SOLVED: To obtain a tube capable of securing required compressive strength even after brazing heat treatment without deteriorating extrudability and corrosion resistance and used for a heat exchanger of an automotive air conditioner by adding specified amounts of Fe, Cu and Mn to Al.

SOLUTION: This extruded tube is composed of, by weight, 0.25 to 0. 70% Fe, 0.03 to 0.15% Cu and 0.05 to 0.45% Mn, and the balance Al. Moreover, this compsn. may be incorporated with one or more kinds of 0.05 to 0.25% Ti and 0.05 to 0.25% Zr. In this way, a fine crystal structure in which the average crystal grain size after brazing heat treatment is ≤150 μm, more desirably ≤100 μm can be obtd. Furthermore, in this extruded tube, impurity elements are included in addition to the elements, but, in the case of the ranges of ≤0.10% Si, ≤0.02% Mg, ≤0.02% Zr, ≤0.01% V and ≤0.002% B, the purpose is not checked.

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CLAIMS

[Claim(s)]
[Claim 1] The extrusion tube characterized by consisting of the remainder aluminum and an unescapable impurity Fe:0.25-0.70%, Cu:0.03-0.15%, and Mn:0.05-0.45% by weight %.
[Claim 2] Ti: The extrusion tube containing one sort (0.05-0.25% and Zr:0.05-0.25%) or two sorts according to claim 1.
[Claim 3] The extrusion tube according to claim 1 or 2 whose diameter of average crystal grain after brazing heat treatment is 150 micrometers or less.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the extrusion tube used for the heat exchanger of the air conditioner for automobiles.
[0002]
[Description of the Prior Art] Since extrusion-molding nature is excellent compared with other metallic materials, aluminum or aluminum alloy is used for various applications as an extruded material. Moreover, since specific gravity is lightly excellent in lightweight nature while thermal conductivity is excellent, aluminum or aluminum alloy is used for the heat exchanger of the air conditioner for automobiles. More specifically, it is used for the tube which a refrigerant passes in a heat exchanger as an extruded material.
[0003] Pure aluminum material (pure aluminum of 99.5% or more of purity) like JIS1050, the aluminum-Mn system alloy, or the advanced alloy that made said pure aluminum material contain Cu 0.4 to 0.6% is mainly used for this extrusion tube.
[0004] By the way, the heat exchanger of the type using an extrusion tube has joined the fin to the tube by putting into a heating furnace and brazing, after it put in the extrusion tube in the shape of meandering and it puts in a fin bending and between them, or after carrying out the laminating of a fin and the tube.
[0005] However, when this brazing heat treatment was performed, the crystal grain of aluminum alloy which constitutes an extrusion tube made it big and rough, and had caused the fall on the strength. That is, the strain by the compression based on bending based on [although it is processed for making height and width of face into a predetermined dimension, usually using a roll after the process of coiling which once rolls round an extrusion tube to a coiled form after extrusion (resizing)] this coiling and ****, and resizing, and **** arises in an ingredient, and crystal grain carries out abnormality growth with recrystallization with this strain as the starting point at the time of brazing heat treatment. And since the fall on the strength after brazing heat treatment turns into a pressure resistance fall as a heat exchanger, it poses a problem practically.
[0006]
[Problem(s) to be Solved by the Invention] The attempt which adds Cu as mentioned above and secures required reinforcement is made to the above fall on the strength. However, when only the amount which is equal to 0.4 - 0.6% and reservation on the strength enough added Cu, it became clear that the corrosion resistance of a tube was reduced. That is, the corrosion rate increases the corrosion to the refrigerant of the tube with which Cu was added while it turns into pitting and intergranular corrosion. Besides Cu, addition of Mn is also considered as mentioned above as an effective element to the fall on the strength. However, it became clear that the increment in the amount of Mn caused the fall of extrusion nature.
[0007] Therefore, this invention offers a technical problem the extrusion tube which can secure required pressure resistance after brazing heat treatment, without reducing extrusion nature and corrosion

resistance.
[0008]
[Means for Solving the Problem] When it inquired in order to solve the above-mentioned technical problem, while being able to aim at improvement in on the strength of a tube by Fe and carrying out optimum dose addition of one sort of Ti and Zr, or the two sorts further, the knowledge of the ability to control big and rough-ization of the crystal grain by the recrystallization at the time of brazing heat treatment was carried out. Moreover, the knowledge of the ability to perform improvement in on the strength of a tube was carried out, securing extrusion nature further by that the reinforcement of a tube can be improved by carrying out optimum dose addition of the Cu, controlling a corrosion resistance fall, and carrying out optimum dose addition of Mn. According to this invention, it is [0009]. This invention is an extrusion tube which is weight % and consists of the remainder aluminum and an unescapable impurity Fe:0.25-0.70%, Cu:0.03-0.15%, and Mn:0.05-0.45% based on the above knowledge. Moreover, the extrusion tube with which this invention contains one sort (Ti:0.05-0.25% and Zr:0.05-0.25%) or two sorts in the above-mentioned presentation is offered. According to this invention, the diameter of average crystal grain after brazing heat treatment can obtain more desirably 150 micrometers or less of detailed crystalline structures 100 micrometers or less.
[0010] The component and the other reasons for limitation of this invention are explained below. <Fe:0.25-0.70%> As an aluminum-Fe system intermetallic compound, in an alloy, Fe crystallizes or deposits and raises the reinforcement after brazing. Moreover, this aluminum-Fe system intermetallic compound serves to control coarsening at the time of brazing heat treatment. At less than 0.25%, since the above effectiveness was not fully able to be acquired, the lower limit was made into 0.25%. Moreover, if an aluminum-Fe system intermetallic compound exists so much, since extrusion nature will be reduced, an upper limit is made into 0.70%. The desirable content of Fe is 0.4 - 0.6%.
[0011] <Cu:0.03-0.15%> Cu is an element contributed to the improvement in on the strength after brazing by dissolving to alloy radical underground. In order to acquire this effectiveness, in this invention, it adds 0.03% or more. However, if it adds so much as mentioned above, in order to reduce the corrosion resistance of a tube, an upper limit is made into 0.15% in this invention. Desirable Cu content is 0.07 - 0.12%.
[0012] <Mn:0.05-0.45%> Mn has the operation which crystallizes or deposits and raises the reinforcement after brazing in an alloy as an aluminum-Mn system intermetallic compound. However, at less than 0.05%, this effectiveness cannot fully be acquired, but if contained exceeding 0.45% on the other hand, the fall of extrusion nature will be caused. Then, this invention makes the amount of Mn 0.05 - 0.45%. The content of desirable Mn is 0.2 - 0.35%. In addition, the work to which an aluminum-Mn system intermetallic compound controls coarsening compared with these intermetallic compounds since it is big and rough compared with the above-mentioned aluminum-Fe system intermetallic compound, aluminum-Ti mentioned later, and an aluminum-Zr system intermetallic compound is small.
[0013] <Ti, Zr:0.05-0.25%> -- as aluminum-Ti and an aluminum-Zr system intermetallic compound, in an alloy, Ti and Zr crystallize or deposit and raise the reinforcement after brazing. Moreover, this aluminum-Ti and an aluminum-Zr system intermetallic compound serve to control coarsening at the time of brazing heat treatment. However, even if less than 0.05% of this effectiveness is insufficient and it exceeds 0.25%, it cannot acquire only the effectiveness of balancing content cost. Therefore, in this invention, it may be 0.05 - 0.25%. The content of desirable Ti and Zr is 0.1 - 0.2%.
[0014] In a <other impurity element> this invention extrusion tube, although an impurity element is contained in addition to the above element, if it is the following range, the purpose of this invention will not be checked.
Si: Less than [0.10%] Less than [Mg:0.02%] Less than [Zn:0.02%] V:0.01% or less B:0.002% or less [0015] What is necessary is just to apply the well-known manufacture approach conventionally, in order to obtain this invention extrusion tube. For example, after obtaining an ingot by the direct chill casting process, the billet for presenting extrusion is created. In a 450-650-degree C temperature requirement, homogenization heat treatment is performed to this billet. While a part of Fe dissolves by this homogenization heat treatment, an aluminum-Fe system intermetallic compound, an aluminum-Mn

system intermetallic compound, aluminum-Ti, and an aluminum-Zr system intermetallic compound deposit uniformly minutely. After an appropriate time, the die which has a predetermined configuration performs extrusion.

[0016]

[Embodiment of the Invention] This invention is explained based on an example below. The billet was created on the alloy presentation (wt.%) and homogenization conditions which are shown in Table 1, and the extrusion tube was created on condition that usual. The extrusion force in this case, an extrusion rate, and the configuration precision of a tube were synthetically evaluated as extrusion nature. Then, like the actual product, coiling and after carrying out resizing processing, maintenance was heat-treated for 5 minutes at 600 degrees C supposing brazing (brazing is called hereafter). The tension test was performed before and after this brazing, and tensile strength was measured. Moreover, in order to check corrosion resistance, the SWAAT trial (between 20 days of duration of test) according to ASTM was performed, and the maximum corrosion depth was measured. The above evaluation and a measurement result are shown in Table 2.

[0017]

[Table 1]

	組成 (wt.%)						均質化処理	備考
No.	Fe	Cu	Mn	Ti	Zr	Al		
1	0.30	0.06	0.33	—	—	Bal.	590℃×5hr	本発明
2	0.33	0.10	0.33	—	—	Bal.	〃	本発明
3	0.35	0.13	0.32	—	—	Bal.	〃	本発明
4	0.35	0.09	0.09	—	—	Bal.	570℃×5hr	本発明
5	0.35	0.09	0.42	—	—	Bal.	590℃×5hr	本発明
6	0.42	0.08	0.33	—	—	Bal.	〃	本発明
7	0.65	0.10	0.35	—	—	Bal.	〃	本発明
9	0.32	0.07	0.32	0.20	0.20	Bal.	〃	本発明
10	0.56	0.12	0.12	—	0.15	Bal.	570℃×5hr	本発明
11	0.48	0.08	0.25	0.10	—	Bal.	590℃×5hr	本発明
12	0.85	0.10	0.18	—	—	Bal.	570℃×5hr	比較例
13	0.40	0.20	0.33	—	—	Bal.	590℃×5hr	比較例
14	0.36	0.12	0.56	—	—	Bal.	〃	比較例
15	0.15	0.02	0.02	—	—	Bal.	550℃×5hr	比較例

No. 15：JIS A1050

[0018]

[Table 2]

No.	押出性	引張強さ（MPa）		平均結晶粒径（μm）	最大腐食深さ（μm）
		熱処理前	熱処理後		
1	◎	108	103	53	148
2	◎	111	105	48	163
3	◎	115	108	56	182
4	◎	107	100	45	156
5	○	121	111	53	155
6	◎	112	106	52	160
7	○	118	109	58	165
9	◎	117	110	48	150
10	○	123	112	47	154
11	◎	119	108	53	160
12	×	125	115	54	159
13	○	127	115	49	352
14	×	121	108	58	145
15	◎	78	65	198	450

＊押出性 ◎：非常に良好 ○：良好 ×：不良

[0019] The extrusion tube concerning this invention is excellent also in corrosion resistance while the reinforcement after brazing is excellent, so that clearly from Table 2. Moreover, it is the level in which extrusion nature does not have a problem, either. Although No.1 of this invention, and 2 and 3 have Fe and equivalent Mn content, Cu content increases them in order of 1-3. If this tensile strength of No.1-3 is compared, it turns out that tensile strength improves as Cu content increases. However, if Cu content increases, it turns out that the maximum corrosion depth becomes large and corrosion resistance is degraded. If Cu content increases to 0.20% like No.13 (example of a comparison), the maximum corrosion depth cannot exceed 350 micrometers and the purpose of this invention cannot be attained.
[0020] In order of No.4, and 1 and 5, although No.4, and 1 and 5 have Fe and equivalent Cu content, Mn content increases them. And Table 2 shows that tensile strength is improving with the increment in Mn content. However, it is in the inclination which is inferior in extrusion nature with the increment in Mn content, when a content is 0.42% like No.5 which are this invention, permissible extrusion nature is shown, but if it becomes the content which exceeds 0.5% like No.14 (example of a comparison), extrusion nature will deteriorate.
[0021] In order of No.1, and 6 and 7, although No.1, and 6 and 7 have Cu and equivalent Mn content, Fe content increases them. And Table 2 shows that tensile strength is improving with the increment in Fe content. However, it is in the inclination which is inferior in extrusion nature with the increment in Fe content, when a content is 0.65% like No.7 which are this invention, permissible extrusion nature is shown, but if it becomes the content which exceeds 0.8% like No.12 (example of a comparison), extrusion nature will deteriorate.
[0022] Although No.9-11 are an example containing one sort of Ti and Zr, or two sorts, it turns out that the extrusion tube excellent in extrusion nature, tensile strength, and corrosion resistance is obtained also in this case.
[0023] Although the diameter of average crystal grain after brazing in Table 2 is shown, each extrusion tube by this invention shows 60 micrometers or less and the detailed crystalline structure. On the other hand, it was checked that the diameter of average crystal grain amounts to about 500 micrometers, and big and rough-ization of recrystallization has produced No.15 by brazing heat treatment.
[0024]
[Effect of the Invention] Above, like explanation, according to this invention, since it considered as the presentation which consists of the remainder aluminum and an unescapable impurity, the extrusion tube

which had extrusion nature, tensile strength, and corrosion resistance can be obtained Fe:0.25-0.70%, Cu:0.03-0.15%, and Mn:0.05-0.45%, by weight %.

[Translation done.]